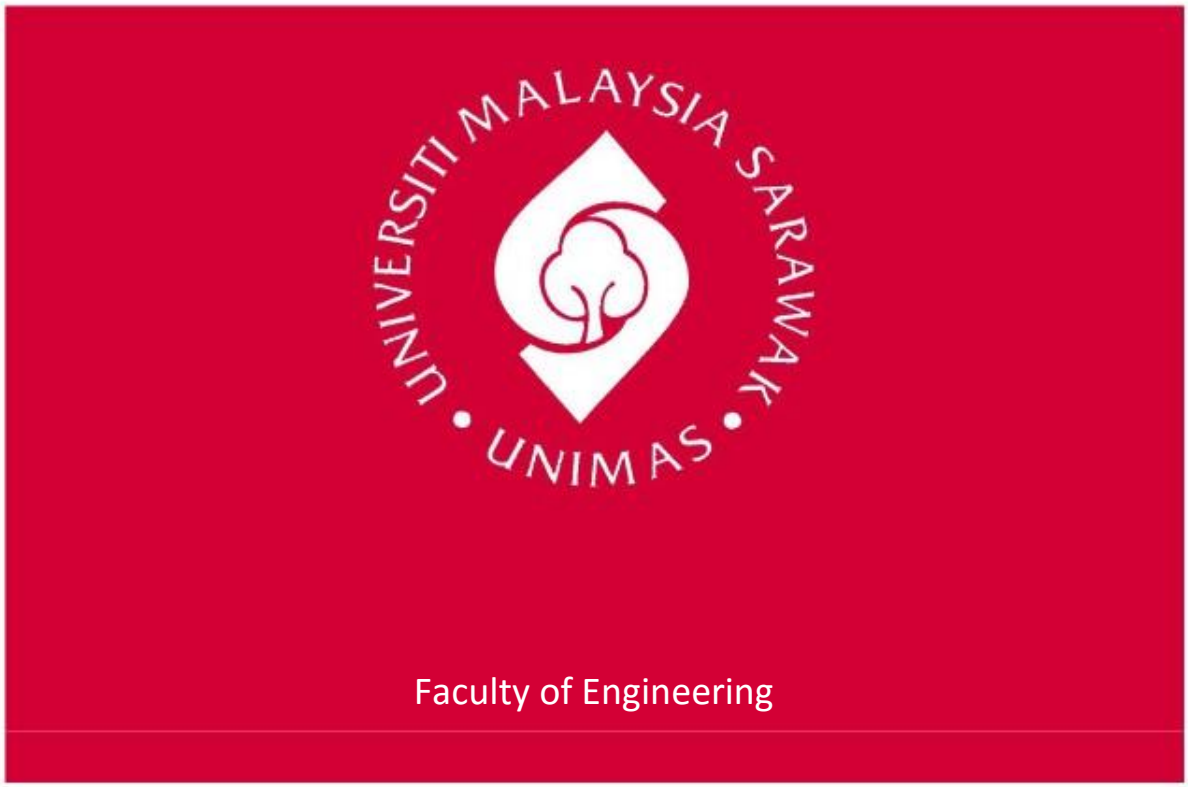

SMART MONITORING AND CONTROL SYSTEM FOR HOUSEHOLD APPLIANCES

Izzul Fitrie Bin Khalid

Bachelor of Engineering (Hons)

Electrical and Electronics Engineering

2019

UNIVERSITI MALAYSIA SARAWAK

Grade: A

Please tick (√)

Final Year Project Report ☑

Masters ☐

PhD ☐

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This declaration is made on the 13TH day of JUNE 2019.

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SMART MONITORING AND CONTROL SYSTEM FOR HOUSEHOLD APPLIANCES

IZZUL FITRIE BIN KHALID

A final year project report submitted in partial fulfilment of
the requirement for the degree of
Bachelor of Engineering (Hons) Electrical and Electronics Engineering

Faculty of Engineering
Universiti Malaysia Sarawak

2019

Dedicated to my family, supervisor and friends

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ABSTRACT

Among all resources in this world, energy is one of the sources that needed to be monitored and controlled as far as the increased electricity day by day is concerned. Consumers are highly unlikely monitor their consumption of electricity by household appliances based as they only know their consumption based on their whole billing by those authorities that send to their home. Overcurrent could be easily occurred when the appliances are not being monitored. Most of the consumers unaware of the life span of the appliances where it is one of the biggest contributions to the excess of energy consumption where statistically 2 to 20% of the 40% of energy consumed by residential buildings and houses is misused through ineffective appliances. Though electricity is very essential in day to day life, the proper utilization of it must be done.

Smart Monitoring and Control System (SMACS) for Household Appliances is introduced where the signification of proposed project is to monitor and control the electricity usage of household appliances based on Internet of Things (IoT). This proposed project is focusing on the on recording the data and store in the cloud storage which the web server (Thingspeak) and also mobile application (Virtuino) access to visualise the data through graph and numerical display. This study provides users with an easy system to monitor and control the power consumption of household appliances using a mobile application.

ABSTRAK

Di antara semua sumber daya di dunia ini, tenaga adalah salah sumber yang perlu dipantau dan dikawal sejajar dengan kenaikan elektrik. Pengguna selalunya kurang menyedari tentang pemantauan penggunaan elektrik peralatan rumah kerana pengguna hanya mengetahui penggunaan mereka berdasarkan bil elektrik yang diberikan oleh pihak berkuasa yang setiap bulan. Penggunaan elektrik berlebigan mudah berlaku apabila peralatan tidak dipantau. Kebanyakan pengguna juga tidak menyedari tentang jangka hayat peralatan yang merupakan salah satu sumbangan terbesar kepada penggunaan tenaga berlebihan. 2 hingga 20% secara statistik dari 40% tenaga yang digunakan oleh bangunan dan rumah kediaman telah disalahgunakan melalui peralatan yang tidak berkesan. Penggunaan and penjagaan elektrik yang berul haruslah dilakukan keran elektrik sangat penting dalam kehidupan seharian.

Smart Monitoring and Control System (SMACS) for Household Appliances telah diperkenalka. Cadangan projek ialah untuk memantau dan mengawal penggunaan elektrik peralatan rumah tangga sebagai fokus projek ini yang berasas *Internet of Things (IoT)* ataupun Internet untuk segalanya . Projek ini juga menumpukan perhatian kepada rakaman dan simpanan data di dalam penyimpanan atas talian yang membolehkan laman sesawang *(Thingspeak)* dan juga aplikasi mudah alih *(Virtuino)* untuk memaparkan data melalui grafik dan paparan berangka. Kajian ini menyediakan pengguna dengan sistem yang mudah untuk memantau dan mengawal penggunaan kuasa peralatan rumah menggunakan aplikasi mudah alih.

TABLE OF CONTENT

LIST OF TABLES

LISTS OF FIGURES

LIST OF ABBREVIATION

A	- Ampere
AC	- Alternating Current
AT	- Attention
CSV	- Comma-Separated Value
DC	- Direct Current
FYP	- Final Year Project
GHZ	- GigaHertz
GSM	- Global System for Mobile
HTML	- Hypertext Markup Language
HTTP	- Hypertext Transfer Protocol
HZ	- Hertz
I	- Current
IDE	- Integrated Development Environment
IOT	- Internet of Things
ISIS	- Institute for Software Integrated Systems
IT	- Information Technology
KBPS	- Kilobits Per Second
KWH	- Kilowatt Hour
LAN	- Local Area Network
LCD	- Liquid Crystal Display
MAX	- Maximum
MBPS	- Megabits Per Second
MGH	- Mega Hertz
MIN	- Minimum
NC	- Normally-closed
NO	- Normally-open
PCB	- Printed Circuit Board
PHP	- Hypertext Preprocessor
PMAS	- Power Monitoring and Switching
RMS	- Root Mean Square
SEB	-Sarawak Energy Berhad

SESB	-Sabah Energy Berhad
SMACS	-Smart Monitoring and Control System
SOC	-System-on-the-chip
TNB	-Tenaga Nasional Berhad
V	-Voltage
Wi-Fi	- Wireless Fidelity
WLAN	-Wireless Local Area Networks
WPAN	- Wireless Personal Area Networks
WSN	- Wireless Sensor Network

CHAPTER 1

INTRODUCTION

1.1 Project Background of Smart Monitoring and Control System (SMACS) for Household Appliances

In Malaysia, electricity is the highest demand than any other usable items as it is expected to be increased gradually in years to come in line with the expansion of urbanization and rapid industrialization as well as the growing population in the country. Statistically, most of the buildings consume up to 48% of the energy globally [1]. 40% of the energy consumed by the buildings in Malaysia where it is divided into the commercial buildings and residential buildings [1].

In this modern era, people utilize household appliances with new technologies. Average standard Malaysian household appliance uses 20 to 30 spread within the house[2]. A vast majority of household appliances can be indicated to be the most needed appliances where it consumes such a large amount of power and energy consumption. Consumers mostly tend to leave their light, fans and other appliances inevitably when they are leaving their home where it resulted to be energy wastage and it is not very efficient behaviour [3]. Other than that, it is unfeasible to be always physically at home all the time but that is not the reason why energy should be wasted [3]. This negligence with regard to the behaviour of the consumers not only can lead to outrageous power consumption and wastage of the electrical energy needed but it can shorten the life span of the household appliances [3]. In conjunction to that case, one of the unseen or unaware of the consumers about the increased of the consumption of electricity bills of their houses are appliances that past their prime or life span date. Old appliances contribute high energy consumption.

Practically, these appliances become unconcerned to the people in such a way that people are unaware of the consumption of the electricity as many of these appliances are excessively used. The increased number of electrical appliances used within a household might bring a greater impact to the electricity consumption. It is not consuming a great amount as a single household appliance, but the sums up of as a total has given a huge impact collectively.

In other word, consumers use electrical energy inefficiently in term of the usage of inefficient household appliances and the lack of knowledge to utilize the electrical energy in daily life efficiently [4]. Technologies are developing where all these problems can be solved. There are a lot of smart devices that can counter these problems, but the cost is considered high for the average outcomes people. On the other hand, management of the electrical consumption should be done by monitoring the household appliances in a better and smart way. Smart Monitoring and Control System (SMACS) for Household appliances is introduced.

Generally, the development of this project is an integration of software and hardware where the software is used more onto monitoring the power usage and the consumption of household appliances and slightly touch on control system which is the overcurrent relay and notification. The development of SMACS consists of Arduino UNO, Wi-Fi module (ESP 8266), 5V relay, Low Current Sensor Breakout (ACS712), and Liquid Crystal Display (LCD). Arduino UNO is a microcontroller used to programme coding for executing output at any instant time and it is also a very capable microcontroller that manage to receive and send information over internet with the help of various type of modules and shield platform but in this case ESP8266 Wi-Fi module is used as the platform. ESP8266 Wi-Fi Module is a popular for its IoT application. Relay is a semiconductor that has the electrical and optical properties to perform the cut-off current and the isolation of input and output and performs switching functions. The execution of the outputs is shown in 2 ways: LCD and Internet of Things (IoT) implementation which is based on web server or mobile application. LCD is used to display the voltage, current and power consumption where web or mobile application is used to visualise the data and trigger alarm.

As few years ago, IoT was already considered as a new technology era for the upcoming generation. IoT is no longer just a buzzword due to the digital technology [5] and now it is realistic technology and become more accessible. IoT represents a world-wide unique system where it can address the interconnected objects in many engineering applications base platforms. The concept of IoT implementation into the real world is made possible through the amalgamation of numerous enabling technologies. IoT helps to improve people's comfort and enhance efficiency as a development of automated smart home and monitoring by using electronic sensors [6].

In the web and mobile applications, the energy usage statistics – power consumption parameters determined. It displays the detailed monitoring of electrical quantities such as Voltage, Current, Power and Energy. The overcurrent or circuit overloading can be detected earlier based on IoT where alarm triggers the consumers.

This urban and suburban areas of IoT users have given numerous benefits in such a way of utilization and conventional invention as far as SMACS is concerned. The significance of SMACS is to create awareness to the consumers on their power consumption practices and to help them to be manageable in managing the power usage. It is also to practice energy saving for the consumers and keep track of their household appliances performances as well as their current behaviour.

1.2 Problem Statements

Among all resources in this world, energy is one of the requirements that needed to be monitored and controlled as far as the increased electricity day by day is concerned. Energy is the soul of the world which is related to the electricity and "electricity" is the word which now rules the world [7].

Consumers are highly unlikely monitored their consumption of electricity by household appliances based as they only know their consumption based on their whole billing that send to them monthly by the Tenaga Nasional Berhad (TNB) for peninsular Malaysia, Sarawak Energy Berhad (SEB) for Sarawak region and Sabah Energy Sdn. Bhd. (SESB) for Sabah partition. Consumers are not aware of the consumption of the household appliances and also do not take their household appliances seriously where most of consumers leave their lighting or even their rice cooker operates when they are not at home. This is a wastage of electricity as well as it is unsafe. Moreover, overloading can easily happen in a house where household appliances such as water heater, cooker and oven are often concurrently being used with such a large amount of current they use[8]. Overloading and non-functioning fuse can caused fire as given a reasonable explanation to create such system[8]. Statistically, 39.3% of the common cost of fire in the residential areas are electrical failure where includes, resistance heating and overcurrent of electrical distribution and electrical appliances [9]. 30% is caused by careless or negligence during human activity such as cooking[9]. It is given another reason to develop parameter electric parameter measurement, monitoring and control system. .Most of the consumers unaware of the life span of the appliances where it is one of the biggest contributions to the excess of energy consumption where statistically 2 to 20% of the 40% of energy consumed by residential buildings and houses is misused through ineffective appliances [1].

Though electricity is very essential in day to day life, the proper utilization of it must be done. The emergence of smart home technology provides people who use electricity a better way of living. The consumption of electricity can be monitored closely and help them to

become more manageable on electricity usage. So, proper utilization of these resources is of immense importance to us.

Household electrical consumption can be monitored by using appropriate techniques is of great significance to the sustainable development of human society [10]. The 21st century has brought us into a real world to a certain degree to advancement in the field of technology where everything is accessible and reliable using smart technology. These discoveries of the smart technologies have brought bigger challenges approaching but at the time it has given a big impact to the society. SMACS will provide the user with a better solution and method to monitor and take control of their homes as well as to practice a good management system and increase the awareness of power supply consumption. Last but not least, it can reduce the cost and financial loss for unnecessary needs of electricity where now it can be monitored using their own smartphone applications as well as it is a low-cost product as compared to the market prices.

1.3 Project Objectives

The following objectives of this study are needed to be considered:

1. To study the impact of electricity consumption using existing smart monitoring and control systems.
2. To design a Smart Monitoring and Control System (SMACS) for Household Appliances that visualizes, and stores data usage of household appliances based on IoT
3. To explore the comparison studies of SMACS with the previous works.

1.4 Scope of Project

The scope of project is focusing on the residential area and at the low voltage side. SMACS can be applied in different field which is as follows:

1. **SMACS can be used at home**

   The system can be used at home to monitor and control the household appliances.
2. **Access the appliances in Internet**

The household appliances can be monitored and controlled from web server and mobile application.

3. **Technology Environment Friendly development**
   SMACS incorporates the power of technology and making an IoT based system. Utilizing the use of gadgets for different prospective.

SMACS is used to monitor and control the household appliances using Arduino UNO with ESP 8266 Wi-Fi module where the consumers can monitor and control using web server and smart phone which is Thingspeak and Virtuino respectively.

1.5 Expected Outcomes

This project aims to produce a SMACS for Household Appliances that is universally used in a home for household appliances. It is able to monitor electricity usage such as voltage, current and power consumption by standalone LCD and a smartphone application and web.

Other than that, the consumers can monitor closely the consumption of the energy used even though they are not at home. They can be more aware of the household appliances status where they could be notified if there is any overcurrent occurs on the relay. Consumers are unaware of their power consumptions make it harder to perform their energy saving practices but giving them a clearer visual on their most needed gadget which is their phone can help to stimulate their requirements, and this is the goal of energy saving.

Finally, energy saving can reduce cost and electricity bills. What matters the most it that, this system is a low-cost system where it is very affordable to the consumers as compared to the existing system that are available in the market now.

1.6 Description of Project

SMACS consists of two modules which are the prototype module and display module. In the prototype module, it consists of a few components. Generally, the current sensor is used to measure current in order to execute power and energy consumption where a program will be uploaded into Arduino UNO whereby mathematical formulas will be added for the required calculations. Wi-Fi Module ESP 8266 is used to access Wi-Fi network for the microcontroller. It is also capable to either host an application or offload Wi-Fi network function from another

processor. Relay is used to act as a switch where the appliances can be operated or dis-operated. LCD is used to execute the output independently without internet. Figure 1.1 shows the block diagram of SMACS for Household Appliances.

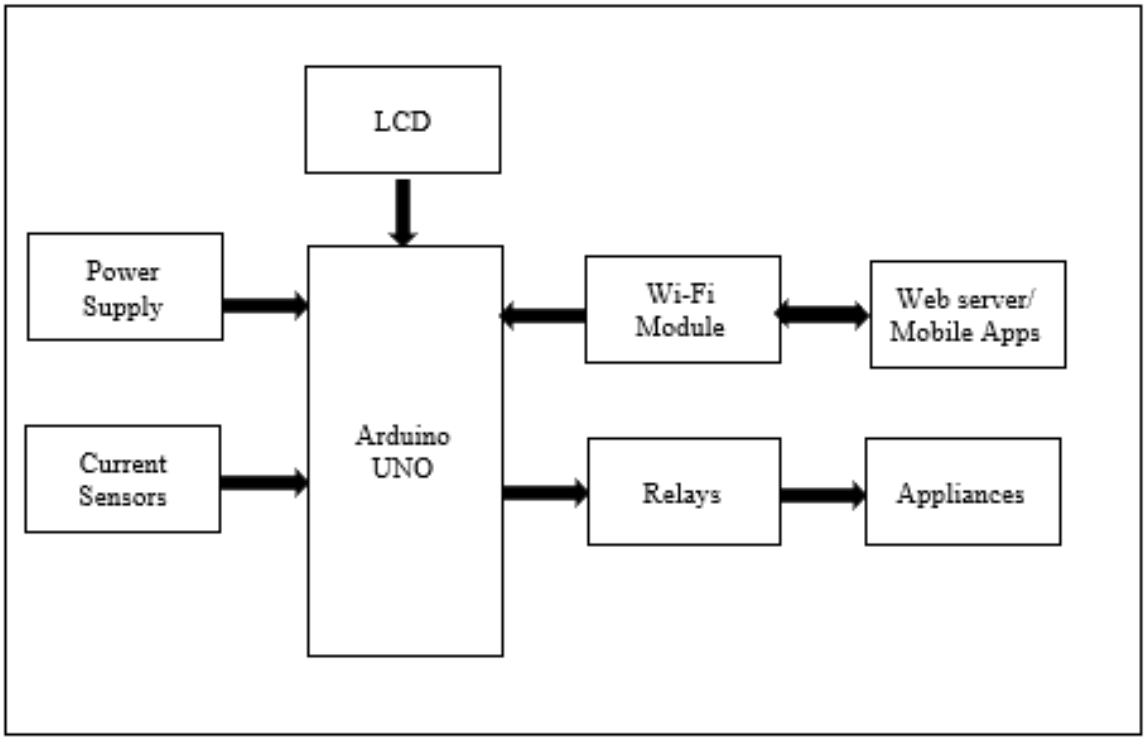

Figure 1.1: Block Diagram of a SMACS for Household Appliances

Figure 1.1 shows the overall architecture design of SMACS. Other than that, the other module of this project is display module. Technically, it is divided into 2 parts. The main part of this system is monitoring system and the minor part of this system is the control system. As for the monitoring parts, the parameters that will be executed and display are as follows:

- Voltages
- Currents
- Power Consumption

These parameters will be shown in the mobile application and web server, but a few of the parameters will be displayed on the LCD. These parameters are the crucial parts of the system. Then, the control system of SMACS is very minor where it is divided into 2; notification and overcurrent relay. Overcurrent Relay System is to control the limit of current used for the appliances. This is used to cut off the current when the appliances are beyond its

limit. This control system is very crucial to protect the appliances and as a safety precaution. The notification system is where the alarm will trigger if the value of current is towards the limit of the current. The overall control system can be done on the mobile application. Figure 1.2 shows the flow of the system; monitoring and control system.

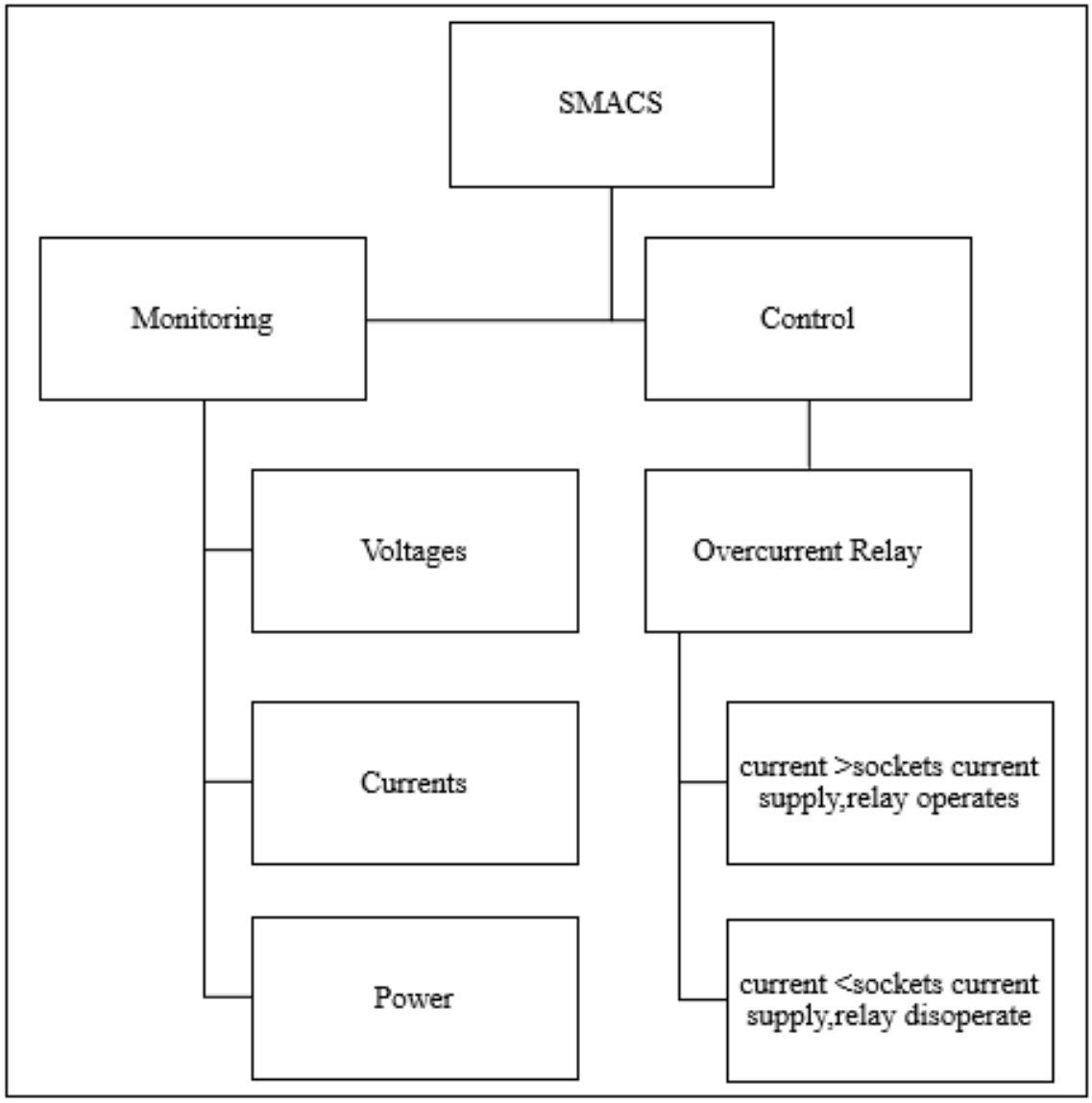

Figure 1.2: Flow Diagram of a SMACS

1.7 Project Outline

The project outline for this project is divided into five (5) chapters which are introduction, literature review, methodology, results and discussions, conclusion and recommendations.

In chapter 1, the general overview of SMACS for Household Appliances will be discussed. This chapter contains the objectives, problem statement, scope of project, expected outcomes, project outlines and the conclusion.

Chapter 2 discusses a literature review where the pilot study and basic understanding of the project will be discussed. In this chapter, previous work researches that have been done by other people will be discussed in detail to understand better and the closest ones are to be selected and applied in this project.

In chapter 3, methodology of the proposed project is discussed where it is listed out the method as to complete SMACS. Other than that, the development process of the project; system design and algorithm of the system will be shown and explained in detail.

In chapter 4, the results and discussion will be shown and explained from the project studies the prototype that is already done as well as the previous finding.

In chapter 5, the conclusion and recommendation will be summarized as well as the limitation of the project. Any improvement in the future will also be discussed in this section.

1.8 Chapter Summary

In this chapter, the background information of the proposed project, SMACS for Household Appliances has been discussed. The problem statement has been identified, three objectives have been targeted, the description of the components have been identified and described such as components, their functions and their flow charts. The project outcomes have also been set to limit the areas of the concern to be targeted in order for the project to be effective to full fill its objectives.